

***Stylidium diplotrichum* (Stylidiaceae): a new scale-leaved trigger plant from south-west Western Australia, with taxonomic and anatomical notes on allied species**

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Abstract

Wege, J.A. *Stylidium diplotrichum* (Stylidiaceae): a new scale-leaved trigger plant from south-west Western Australia, with taxonomic and anatomical notes on allied species. *Nuytsia* 16(1): 183–197 (2006). A new scale-leaved trigger plant with conservation priority, *Stylidium diplotrichum* Wege, is described and illustrated. Revised taxonomic descriptions and notes are also provided for the priority species *S. pseudohirsutum* Mildbr. and *S. expeditionis* Carlquist, and the more commonly occurring *S. hirsutum* R.Br. and *S. crossocephalum* F.Muell. Leaf anatomy data are provided for all species. The location of the stomata is shown to be taxonomically informative.

Introduction

Stylidium subgenus *Tolypangium* (Endl.) Mildbr. section *Squamosae* (Benth.) Mildbr. comprises approximately 20 species of perennial trigger plants, all of which are endemic to the south-west of Western Australia. Members of this section are often referred to as “scale-leaved” trigger plants since they are characterised by membranous scale-leaves that are distributed around or amongst a basal rosette of linear, grass-like leaves. Despite the similarity in habit between these species, allied species often show differences in flower morphology, geographic distribution, habitat preference, chromosome number and karyotype (Carlquist 1969; James 1979; Coates 1982; Lowrie *et al.* 1998).

Examination of the material housed at PERTH uncovered two scale-leaved specimens, collected in the 1970’s from the Lesueur region, not referable to any of the known taxa from section *Squamosae*. Subsequent field searches relocated this entity and confirmed it to be a distinct new species. A description and illustration are provided here, along with revised descriptions for the scale-leaved species *S. pseudohirsutum* Mildbr., *S. expeditionis* Carlquist, *S. hirsutum* R.Br. and *S. crossocephalum* F.Muell. These species share a number of features in common with the new species and are included here for comparative purposes only. A complete revision of section *Squamosae* is in progress and will be published in due course.

Materials and methods

This study is based on herbarium specimens housed at AD, BM, CANB, CGE, K, MEL, P, PERTH, RSA and W, and on the field observations of the author. The majority of morphological characters were

coded using a combination of fresh, spirit and herbarium material. Corolla lobe measurements were based solely on the following spirit collections: *S. crossocephalum* – Wege JAW 22, JAW 590, JAW 596, JAW 606, JAW 615, JAW 622, JAW 634, JAW 727; *S. diplotrichum* – JAW 730, ADC 272; *S. expeditionis* – JAW 697; *S. hirsutum* – JAW 165, JAW 295, JAW 298, JAW 819, JAW 828, JAW 832, JAW 840; *S. pseudohirsutum* – JAW 1142.

Anatomical investigations were conducted on leaf material sampled from 1 plant from the following populations: *S. crossocephalum* – Wege JAW 22, JAW 606; *S. diplotrichum* – JAW 730, ADC 272; *S. expeditionis* – JAW 697; *S. hirsutum* – JAW 165, JAW 298; *S. pseudohirsutum* – JAW 302. Leaves were fixed in 2.5% glutaraldehyde in phosphate buffer or FAA (commercial formalin, glacial acetic acid, and 70% ethanol in the ratio of 1:1:18 parts, respectively). This material was dehydrated, infiltrated and embedded in glycol methacrylate (GMA) according to standard methods (Feder & O'Brien 1968). Transverse and longitudinal sections were made at 2.5 µm using a glass knife rotary microtome, then stained with Toluidine Blue pH 4.4 and mounted in water or paraffin oil for examination using light microscopy (O'Brien & McCully 1981). Anatomical photographs were taken using a Zeiss Axioplan 2 Microscope. The distribution pattern of the stomata, visible under a dissecting microscope as longitudinal bands, was confirmed on all herbarium specimens examined.

Data were recorded as a DELTA dataset (Dallwitz *et al.* 1993), from which species descriptions were generated. Maps were compiled using NatureMap, a departmental mapping application.

Leaf anatomy

The epidermis comprises a single row of thick-walled, axially elongated cells. With the exception of *S. expeditionis*, these cells are obliquely arranged (Figure 1A) and consequently the epidermis appears 1–2 cells thick in transverse section (Figures 1B–E). This unusual feature, first documented by Burns (1900) and later used by Mildbraed (1908) in his infrageneric classification of *Stylidium*, is characteristic of the scale-leaved trigger plants as well as some perennial species from other sections (Mildbraed 1908; Wege, unpublished data). The epidermal cells in *S. expeditionis* are usually transversely arranged and therefore only one cell layer is typically seen in transverse section (Figure 1F). The cross walls are, however, oblique in some cases (Figure 1G) and as such the epidermis occasionally appears two cells thick in transverse section.

Fibrous papillae may form from projections of the thickened epidermal cells. They are abundant across the leaf surface in both *S. crossocephalum* and *S. expeditionis*, giving the leaves a densely pubescent appearance. The papillae vary in density in *S. diplotrichum*: there is usually an even coverage in the lower portion of the leaf, but they are usually restricted to the midrib region on the distal portion of the leaf. *Stylidium pseudohirsutum* typically has scabrous leaves; however, the papillae vary in density between and within populations, and the occasional plant has glabrous leaves. Conversely, the leaves in *S. hirsutum* are typically glabrous, but papillae are present in several populations (see notes under that species).

The leaves of *S. hirsutum*, *S. pseudohirsutum* and *S. crossocephalum* have involute margins (Figures 1B–D). Although the occurrence of involute leaf margins was accurately noted by Mueller (1868) in his description of *S. crossocephalum*, and later by the anatomist Burns (1900), members of section *Squamosae* have most commonly been described as possessing revolute margins (Bentham 1869; Mildbraed 1908; Erickson 1958; Carlquist 1969; Lowrie *et al.* 1998). This feature is likely to have been misinterpreted since the leaves tend to twist over the course of their length. The involute margins

provide a degree of protection for the stomata, which are found in two bands, located on either side of the midvein on the adaxial surface. They occur in association with transversely orientated epidermal cells with thinner walls and thick cuticles. Two additional bands of stomata are present on the abaxial surface in both the new species – *Stylidium diplotrichum* Wege (Figure 1E) and *S. expeditionis* (Figure 1F). In the latter species, the leaves are distinctly bisulcate on both surfaces. The distribution of stomata is a stable taxonomic character in this species complex and they are readily visible on fresh or herbarium specimens with the aid of a dissecting microscope or hand lens.

Palisade tissue is discrete in all species and consists of one to three layers of anticlinally-elongated cells which are lobed and axially elongated in longitudinal section (Figure 1A, G). The palisade is located beneath the fibrous epidermal cells. More rounded spongy mesophyll cells are present to the inside of the stomata channels. Sclerenchyma is associated with the central vascular bundle in all species.

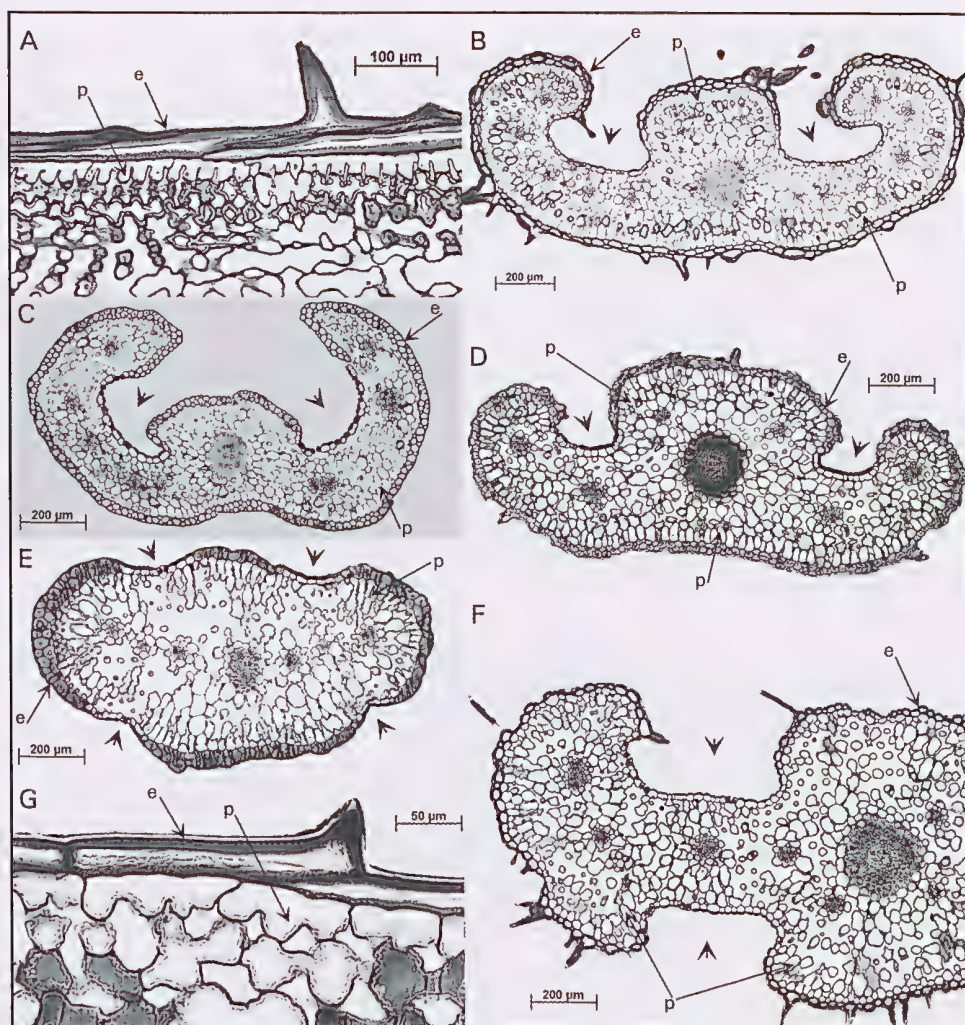


Figure 1. Leaf anatomy in selected members of *Stylidium* subgenus *Tolypangium* section *Squamosae*. A – L.S. of *S. crossocephalum* (JAW 288); B – T.S. of *S. crossocephalum* (JAW 22); C – T.S. of *S. hirsutum* (JAW 165); D – T.S. of *S. pseudohirsutum* (JAW 302); E – T.S. of *S. diplotrichum* (ADC 272); F – partial T.S. of *S. expeditionis* (JAW 697); G – L.S. of *S. expeditionis* (JAW 697), showing a transverse epidermal crosswall to the left and an oblique cross wall to the right. e = epidermis, p = palisade, arrows indicate the position of the stomata.

Taxonomy

***Stylidium diplotrichum* Wege, sp. nov.**

Stylidio pseudohirsuto affini, sed foliis utrinque bisulcatis et corollae lobis anterioribus obtusis.

Typus: Tootbardie Road, SE of Eneabba [precise locality withheld], 24 Oct. 2002, J.A. Wege JAW 730 (*holo*: PERTH 06656358; *iso*: MEL).

Perennial herb 14.5–40 cm high. *Glandular trichomes* 0.1–0.7 mm long; heads red, ellipsoid; stalks translucent. *Eglandular (pilose) trichomes* 1–6.5 mm long. *Stems* short, or somewhat condensed, internodes 0.2–3.1 cm long, glabrous. *Stilt roots* glabrous. *Leaves* arranged in a rosette at the stem apex, linear, 1–11.7 cm long, 0.6–1.2 mm wide, apex mucronate, margin entire; surface scabrous, papillae c. 0.1 mm long, largely confined to midrib on distal portion of leaf; stomata confined to 2 longitudinal grooves on both the adaxial and abaxial surfaces. *Scale-leaves* 0.5–2.5 cm long. *Scape* 12–32.5 cm high, 0.9–1.7 mm wide, glandular and pilose throughout. *Inflorescence* paniculate or almost head-like, 3–10-flowered; inflorescence units 1–5-flowered, 2–8 cm long, upper units flowering first. *Bracts* 8.5–13 mm long, 1–1.8 mm wide; external surface glandular, pilose hairs present or absent; inner surface glandular. *Bracteoles* 2.6–6.8 mm long. *Pedicels* 1–4 mm long, glandular. *Hypanthium* ellipsoid, 3.5–5.5 mm long, 2.5–3.3 mm wide, glandular and pilose. *Calyx lobes* free, 4.8–8.3 mm long, 0.6–1.9 mm wide, glandular, pilose hairs present or absent, inner apex glandular, margin entire, apex subacute. *Corolla* white; abaxial surface speckled purple, glandular; tube 6.5–8.8 mm long; lobes vertically-paired, elliptic, base truncate; anterior lobes cymbiform, occasionally overlapping at apex, 7.5–13.8 mm long, 3.5–8 mm wide, margin glandular on sinus-side; posterior lobes 7.5–13.2 mm long, 4–7.7 mm wide, fused at base. *Labellum* boss white, elliptic, 1–1.6 mm long, 0.6–0.9 mm wide; margin papillose, white with a pink apex, apex 0.5–1.4 mm long; lateral appendages 0.5–1.2 mm long, white with pink tips. *Throat appendages* 4, anterior appendages wing-like and fused at base to a broadly linear posterior tooth; anterior appendages white with a small pink-red patch on the posterior corner, 1.2–2.5 mm long, 1.2–2.5 mm wide; posterior appendages white with pink-red markings near the apex and a yellow tip, 1.5–2.5 mm long. *Column* 11.5–15.3 mm long; anthers greenish, subtending hairs absent; pollen yellow; stigma sessile, bilobed. *Capsule* not viewed. *Seeds* pale orange-brown; broadly ellipsoid to ovoid; 2–2.5 mm long, 1.2–1.6 mm wide. (Figures 2, 3B)

Specimens examined. WESTERN AUSTRALIA: Mount Lesueur [precise locality withheld], 30 Oct. 2002, A. Crawford ADC 272 (CANB, NSW, PERTH); Mount Lesueur, 23 Oct. 1979, E.A. Griffin 2336 (PERTH); 4 km NNW of Mount Lesueur, 6 Nov. 1979, E.A. Griffin 2488 (PERTH).

Distribution. Known only from in the northern sandplains east of Jurien Bay. (Figure 3A)

Habitat. Favours soils with high clay content bearing *Acacia* and Myrtaceous shrubland.

Phenology. Flowering specimens are known from late September to early November.

Conservation status. Conservation Codes for Western Australian Flora: Priority Two. This species is known from only four collections, three of which are from Lesueur National Park. The fourth, the type locality, is from a degraded roadside. Surveys are required in order to document population sizes and establish the geographic range of this species.

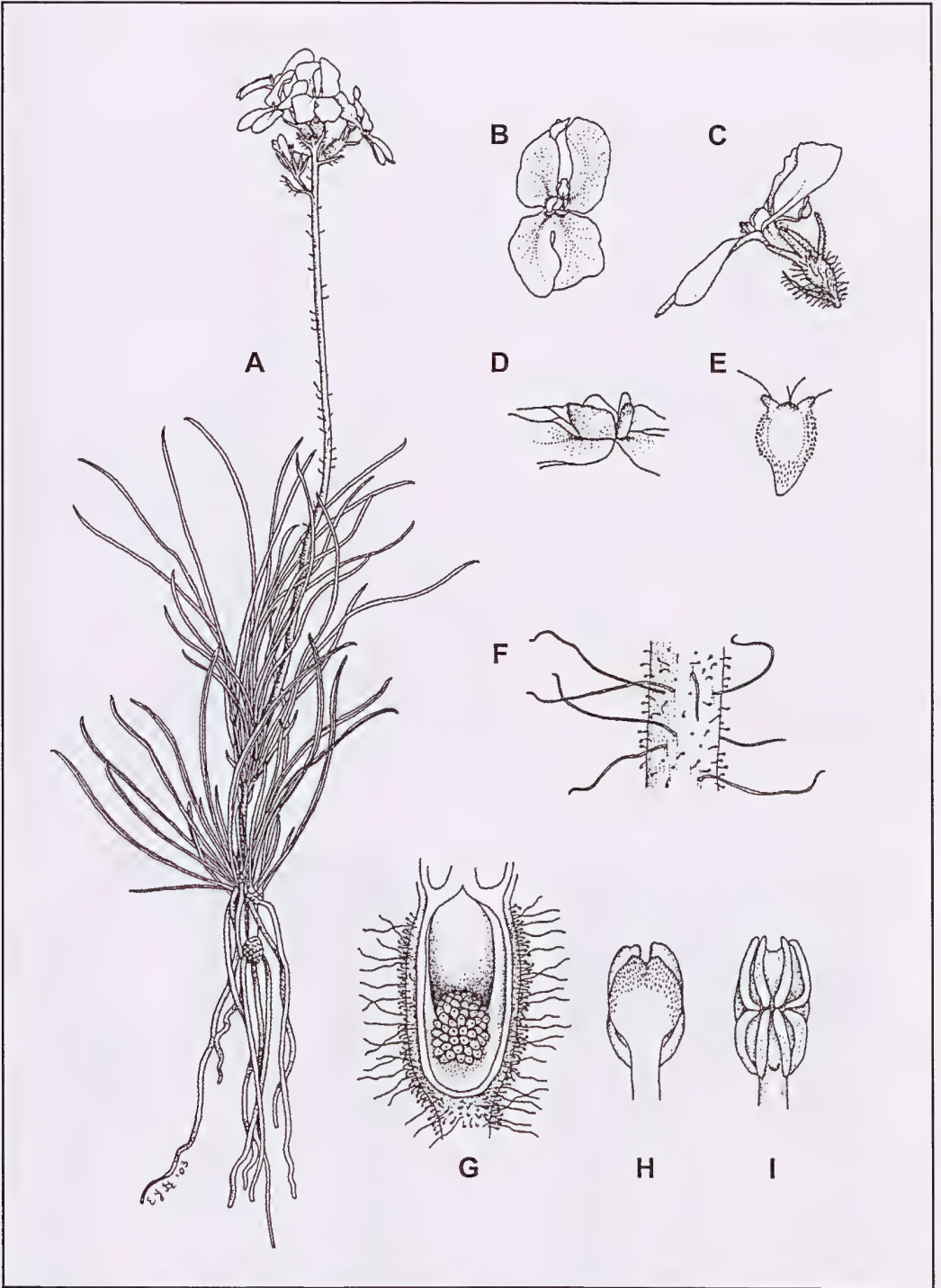


Figure 2. *Stylidium diplotrichum*. A - habit; B - flower; C - side view of flower; D - throat appendages; E - labellum; F - portion of scape showing shorter glandular trichomes and longer, eglandular trichomes; G - L.S. through the hypanthium; H - connective; I - empty anther locules with developing 2-lobed stigma. Drawn from Wege JAW 730.

Etymology. The specific epithet is of Greek origin (*diplois* = two, *thrix* = hair) and refers to the two forms of trichomes (glandular and eglandular) that are present on the inflorescence.

Notes. *Stylidium diplotrichum* closely resembles *S. pseudohirsutum*, with both species possessing a few-flowered inflorescence, short pedicels, glandular and eglandular hairs on the scape, a corolla tube exerted beyond long calyx lobes, and similar throat appendages. Both taxa also have comparable habitat preferences although they are geographically disjunct (Figures 3A, 4A). *Stylidium diplotrichum* can be morphologically differentiated from *S. pseudohirsutum* by the shape of the corolla lobes, particularly the anterior (upper) lobes, which are broad and rounded at the apex (Figure 3B) as opposed to tapered (Figure 4B). Distinguishing features of *S. diplotrichum* that are more readily viewed on herbarium material are the bisulcate leaves that have mucronate rather than subacute apices, and the presence of a glandular tomentum on the inner apex of the floral bracts and calyx lobes.

Stylidium diplotrichum may also be confused with *S. expeditionis* as both species possess bisulcate leaves and a similar inflorescence structure; however, *S. diplotrichum* has both long eglandular and shorter glandular hairs on the scape rather than just the latter, and a glandular tomentum on the inner apex on the floral bracts and calyx lobes (glabrous in *S. expeditionis*). There is a tendency for *S. diplotrichum* to have narrower leaves that are less prominently grooved, and which possess a less dense and shorter indumentum. In addition, the corolla shape in these two taxa is markedly different. (Figures 3B, 5B)

Stylidium diplotrichum shares with *S. hirsutum* a tomentum of eglandular hairs on the scape and hypanthium with; however, *S. hirsutum* lacks glandular hairs along the length of the scape, has shorter calyx lobes, corolla lobes that are typically smaller and pink instead of white, and leaves with stomata restricted to the adaxial surface. The bisulcate leaves of *Stylidium diplotrichum* also distinguish this species from other scale-leaved taxa that grow in the northern sandplain region including *S. crossocephalum*, *S. stenosepalum* E. Pritz. and members of the *S. caricifolium* Lindl. species complex.

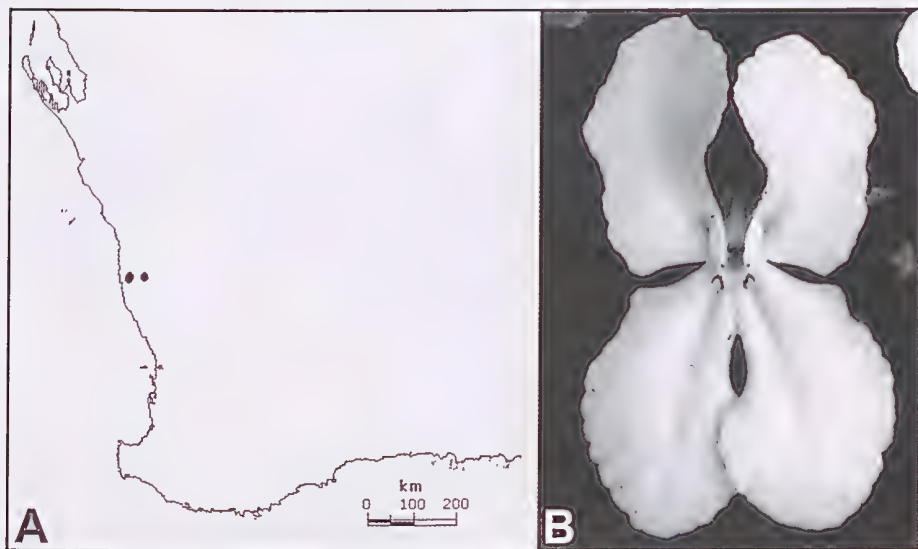


Figure 3. *Stylidium diplotrichum*. A – distribution map; B – flower (Wege JAW 730).

Stylidium pseudohirsutum Mildbr. in A. Engler, Pflanzenreich IV, 278: 76 (1908). *Type*: West-Australien: Ohne Standort [Western Australia], *J. Drummond* Ser. 5 No. 353 (*lecto*, here designated: W!; *isolecto*: BM! (2 sheets), CGE!, K!, MEL 2156060!, P!).

Illustrations. Mildbraed (1908) Figure 21 A–B, p. 75; Carlquist (1969) Figures 98–100 (as photographs), p. 55; Grieve & Blackall (1982) No. 23, p. 737 & Plate IX (photograph).

Perennial herb 9–42 cm high. *Glandular trichomes* 0.2–1 mm long; heads red-black to black, ellipsoid; stalks translucent. *Eglandular (pilose) trichomes* 1–5 mm long. *Stems* somewhat condensed. *Stilt roots* glabrous. *Leaves* arranged in a rosette at the stem apex, linear, 2–16 cm long, 0.6–1.3 mm wide, margin involute, apex subacute; surface scabrous, papillae c. 0.1 mm long, dense to sparse (rarely absent); stomata confined to 2 longitudinal bands on the adaxial surface. *Scale-leaves* 0.5–3.5 cm long. *Scape* 7.5–30 cm high, 0.5–1.2 mm wide, pilose throughout, glandular trichomes sparse to absent on lower half and more common on upper portion. *Inflorescence* unbranched, 1–6-flowered, flowers opening from apex to base. *Bracts* 3.6–8 mm long, 0.9–1 mm wide, external surface glandular and pilose, inner surface glabrous. *Bracteoles* 1.5–3 mm long. *Pedicels* 1.5–6 mm long; glandular, pilose hairs present or absent. *Hypanthium* ellipsoid, 3–6.5 mm long, 1.5–2.8 mm wide, glandular and pilose. *Calyx lobes* free, 3.7–7.5 mm long, 0.8–2.2 mm wide, glandular, pilose hairs present or absent, inner apex glabrous, margin entire, apex subacute. *Corolla* white to creamy-yellow; abaxial surface speckled purplish-brown, glandular; tube 6.5–9 mm long; lobes vertically-paired; anterior lobes lanceolate to falcate, typically cymbiform, 7–18 mm long, 2.5–4.8 mm wide, margin glandular hairy on sinus-side; posterior lobes elliptic to lanceolate, apex subacute to obtuse, 8.7–17 mm long, 4.5–7.3 mm wide, fused at base. *Labellum* boss white to yellow, ovate to elliptic, 1.1–2 mm long, 0.6–0.8 mm wide; margin papillose, irregular, white or yellow and pink-red, apex 0.3–1.3 mm long; lateral appendages 0.6–1.1 mm long, white to yellow with pink-red tips. *Throat appendages* 4, anterior appendages wing-like and fused at base to a broadly linear, entire or bilobed posterior tooth; anterior appendages white, 1.8–2.8 mm long, 1.8–2.5 mm wide; posterior appendages white with pink-red tips, 1.5–2.5 mm long. *Column* 15–18 mm long; anthers greenish, subtending hairs absent or present; pollen yellow; stigma sessile, bilobed. *Capsule* 5.5–7 mm long. Seed not viewed. (Figure 4B)

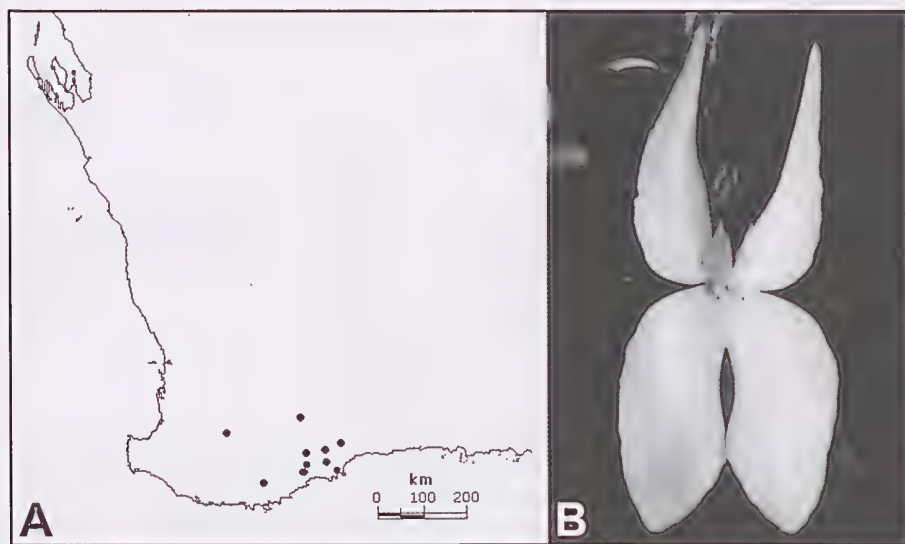


Figure 4. *S. pseudohirsutum*. A – distribution map; B – flower (Wege JAW 1142).

Selected specimens. WESTERN AUSTRALIA: c. 2 miles W of Needilup on Jerramungup–Ongerup Rd, 8 Nov. 1967, *S. Carlquist* 4033 (CANB, MEL, NSW, PERTH, RSA); Shire Reserve No. 800 at Kamballup, 26 Nov. 1986, *D. Coates* 118.1 (PERTH); Hill above S bank Pallinup River, 1 Nov. 1988, *E.J. Croxford* 6251 (PERTH); 5 miles N of Bremer Bay, 28 Nov. 1960, *A.S. George* 1730 (PERTH); Kalgan Plains Reserve, 15 km W of Kamballup, 27 Nov. 1986, *G.J. Keighery & J.J. Alford* 1725 (PERTH); Reserve 1736, Beaufort River flats, 4.9 km N of Robinson Rd on W side of Albany Hwy, 18 Nov. 1999, *B. Loudon* BLO 13 (PERTH); Beaufort River Bridge Reserve, 19 Nov. 1989, *A. Lowrie* 247 (PERTH); 14 miles E of Jerramungup, 10 Nov. 1963, *K.R. Newbey* 1191 (PERTH); 30 km SE of Jerramungup, Fitzgerald River National Park, 12 Nov. 1984, *K.R. Newbey* 10854 (PERTH); 14 km WNW of Mount Drummond, 24 Nov. 1985, *K. Newbey* 11047 (PERTH); 700 m W along Woogenilup Rd from Chester Pass Rd, Kamballup, 17 Nov. 1996, *J.A. Wege, R. Butcher & F. Valton* JAW 302 (PERTH); 150 m W of Murray Rd on Gordon Inlet Rd, near Bremer Bay, 2 Dec. 2003, *J.A. Wege* 1142 (PERTH).

Distribution. Occurs from the Arthur River region south to the Stirling Plains and east to Fitzgerald River National Park. (Figure 4A)

Habitat. Prefers clayey soils in mallee, *Acacia* or Myrtaceous shrublands.

Phenology. Flowering specimens have been recorded from November and December.

Conservation status. Conservation codes for Western Australian Flora: Priority Three. Currently known from a handful of small populations within conservation reserves. Not under immediate threat but further surveys and monitoring are recommended.

Typification. The specimen housed at W is chosen here as the lectotype as it has been annotated by Mildbraed. Mildbraed (1908) did not know the region of Western Australia from which the type collection was made; however, according to Erickson (1969) and in agreement with the currently known range of this species, it was acquired by Drummond somewhere between the Stirling and Mount Barren Ranges.

Chromosome number. Coates (1982) recorded a count of $n = 8$; however no voucher specimen has been located at PERTH or UWA.

Notes. *Stylidium pseudohirsutum* is morphologically similar to *S. diplotrichum*, as discussed in the notes for the latter species.

Stylidium expeditionis Carlquist, *Aliso* 8: 453 (1976). *Type:* Scrubby area at northwestern corner of Tutanning Reserve E of Pingelly, Western Australia, 9 Oct. 1974, *S. Carlquist* 5960 (*holo:* RSA!; *iso:* GH *n.v.*, K (2 sheets)!, MEL!, NSW!, PERTH 1139401!, RSA!, US *n.v.*).

Illustrations. Carlquist (1976) Figures 13–21 (as photographs), pp. 454 & 456; Grieve & Blackall (1982) No. 21d, p. 53 of supplement.

Perennial herb 12–42 cm high. *Glandular trichomes* 0.15–0.6 mm long; heads red-black to black, ellipsoid; stalks translucent to yellowish. *Eglandular (pilose) trichomes* absent. *Stems* short, or somewhat condensed, internodes 0.4–1 cm long, glabrous. *Stilt roots* glabrous. *Leaves* arranged in a rosette at the stem apex, linear, 4.5–12 cm long, 0.7–3 mm wide, margin entire, apex subacute; surface pubescent, papillae 0.2–0.4 mm long; stomata confined to 2 longitudinal grooves on both the adaxial and abaxial surfaces. *Scale-leaves* 0.4–2.5 cm long. *Scape* 11–33 cm high, 0.4–2 mm wide, glandular throughout. *Inflorescence* paniculate, 3–17-flowered; inflorescence units 2–7-flowered, 2–7.5 cm long, upper units

flowering first. Bracts 2.5–8 mm long, 1.2–2 mm wide, external surface glandular, inner surface glabrous. Bracteoles 0.9–2.6 mm long. Pedicels 3–7 mm long; glandular. *Hypanthium* ellipsoid, 3.2–5 mm long, 1.3–3.2 mm wide, glandular. Calyx lobes partly fused (2 fused and 3 free), 2.8–6 mm long, 0.6–1 mm wide, glandular, inner apex glabrous, margin entire, apex subacute. *Corolla* white to pale mauve, yellow–brown in bud, throat white; abaxial surface glandular; tube 6–7 mm long; lobes vertically-paired, spatulate, cymbiform, sometimes overlapping at apex; anterior lobes 8.5–10.5 mm long, 6.2–8.5 mm wide, margin glandular on sinus-side; posterior lobes 6.2–8.5 mm long, 5.5–7.5 mm wide, fused at base. *Labellum* boss white, ovate, 0.7–1.2 mm long, 0.4–0.6 mm wide; margin papillose, white, sometimes tipped purple-black, apex 0.3–0.4 mm long; lateral appendages 0.6–0.8 mm long, white tipped pink. *Throat appendages* 6, white tipped dark pink; anterior appendage wing-like, 1.4–2 mm long, 0.6–0.9 mm wide; posterior appendages tooth-like, entire or fused at base, 0.7–1.2 mm long. *Column* 11–11.5 mm long; anthers red–black, subtending hairs absent; pollen white or yellow; stigma sessile, entire, elliptic. *Capsule* 4–6 mm long. *Seed* not viewed. (Figure 5B)

Selected specimens. WESTERN AUSTRALIA: Highbury State Forest, 20 km S of Narrogin, 26 Oct. 1989, K. Atkins KJA 89013 (PERTH); Highbury State Forest, 20 km S of Narrogin, 26 Oct. 1989, K. Atkins KJA 89014 (PERTH); Tutanning Reserve, SE of Pingelly, 16 Nov. 1965, A.S. George 7356 (PERTH); Property of Bruce Mitchell, N side of Dongolocking Rd, 30 Oct. 1991, F.H. & M.P. Mollemans 4617 (PERTH); Highbury Block State Forest 52, N of Forestry Rd, 15 Oct. 1999, C. Taylor, P. Rose & G. Warren 377 (PERTH); Coleman Block, Highbury Forest, 19 Sept. 1999, G. Warren, C. Taylor & P. Rose 432 (PERTH); Jarrah Road, Tutanning Reserve 21 Oct. 2002, J.A. Wege JAW 697 (PERTH).

Distribution. Currently known from several disjunct populations in the Avon region, from north-west of Dumbleyung to Tutanning Reserve and south to Highbury. (Figure 5A)

Habitat. Favours gravelly yellow-brown sandy loam or white sand over laterite in Proteaceous and Myrtaceous scrub/heath.

Phenology. Flowers have been recorded from September to November.

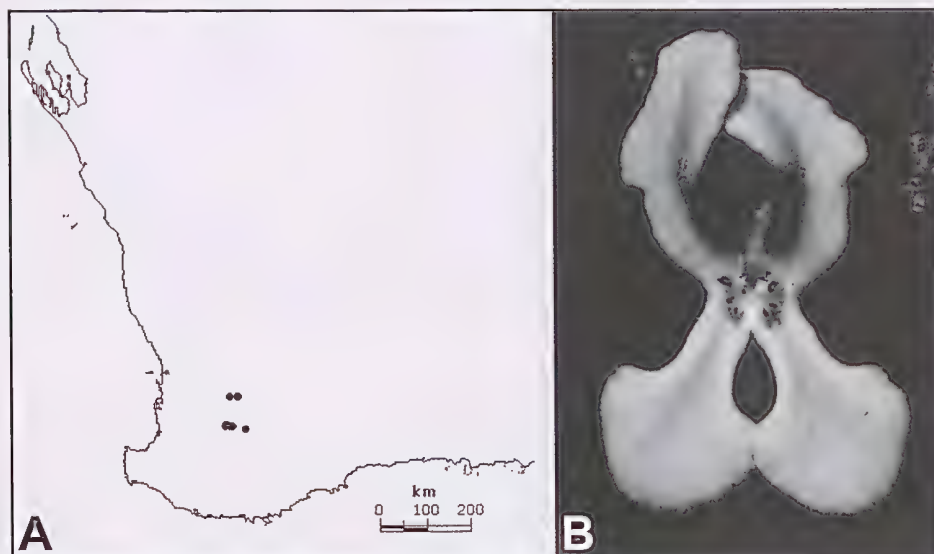


Figure 5. *S. expeditionis*. A – distribution map; B – flower (Wege JAW 697).

Conservation status. Conservation codes for Western Australian Flora: Priority Four. This species is only known from a handful of populations across 3 disjunct regions. Not immediately under threat.

Chromosome number. James (1979) recorded a count of $n = 8$ from a population within Tutanning Reserve. No voucher specimen has been located at either PERTH or UWA.

Notes. With its spatulate, subequal corolla lobes, *Stylidium expeditionis* has a distinctive corolla outline (Figure 5B). It is also readily distinguishable from *S. pseudohirsutum*, *S. hirsutum* and *S. crosssocephalum* by its bisulcate leaves, and lack of eglandular hairs on any part of the inflorescence. Differences to *S. diplotrichum* are discussed under the notes for that species.

Stylidium crosssocephalum F.Muell., *Fragm. Phyt. Austral.* 6: 5 (1868). Base name for *Candollea crosssocephala* (F.Muell.) F.Muell. *Syst. Census Austral. Pl.* 85 (1882). *Type:* In Australia occidentali [Western Australia], *J. Drummonds.n.* (*lecto*, here designated: MEL 2156184!; *isolecto*: K 000060263!, MEL 2156185!).

Illustrations. Mueller (1892); Erickson (1958) Plate 47, Nos. 11-19, p. 156; Grieve & Blackall (1982) Frontispiece & No. 18, p. 735.

Perennial herb 8–36 cm high. *Glandular trichomes* 0.3–1.5 mm long; heads red-black, ellipsoid; stalks translucent. *Eglandular (pilose) trichomes* 0.7–4 mm long. *Stems* short, internodes 0.2–6 cm long, glabrous. *Stilt roots* scabrous. *Leaves* arranged in a rosette at the stem apex, linear, 1.5–13.5 cm long, 0.6–2.3 mm wide, apex mucronate, margin involute; surface scabrous, papillae 0.1–0.6 mm long; stomata confined to 2 longitudinal bands on the upper surface. *Scale-leaves* 0.5–3.2 cm long. *Scape* 5–40 cm high, 0.5–2.7 mm wide, glabrous. *Inflorescence* unbranched, head-like, 10–c. 18-flowered, flowers opening from apex to base. *Bracts* 9.5–19 mm long, 2.8–5.4 mm wide, external surface scabrous, inner surface glabrous or scabrous. *Bracteoles* 8–11.5 mm long. *Pedicels* 1–5 mm long, glabrous. *Hypanthium* obloid to ellipsoid, 3–4.5 mm long, 1.7–2.9 mm wide, pilose on upper half. *Calyx lobes* partly fused (2 fused and 3 free), unequal in length (with two much larger than the remaining three), 6.3–11 mm long, 1.6–2.6 mm wide, scabrous, inner apex glabrous, margin hyaline, apex mucronate. *Corolla* white (rarely pale pink), throat markings pink-red; abaxial surface glandular; tube 6–7.5 mm long; lobes vertically-paired; anterior lobes narrowly ovate, curved inward and cymbiform, sometimes overlapping at apex; 8.2–11.2 mm long, 3.6–4.7 mm wide; posterior lobes elliptic to oblong, apex obtuse, 7.5–10.3 mm long, 3–4.7 mm wide, fused at base. *Labellum* boss orbicular, 0.7–1.1 mm long, 0.7–0.9 mm wide; margin entire; terminal appendage white, 2.4–3.6 mm long; lateral appendages absent, or present, 0.1–0.5 mm long. *Throat appendages* 6, anterior appendage wing-like, white or white with red-pink to purplish markings, 3.1–5.2 mm long, 1–1.6 mm wide; posterior appendages subulate, white tipped red-pink to purplish, 0.8–2.3 mm long. *Column* 12–15.6 mm long; anthers yellow to greenish, subtending hairs absent; pollen yellow, stigma shortly stalked, entire, circular. *Capsule* 4.8–6 mm long. *Seeds* pale orange-brown, ellipsoid, 1.6–2.2 mm long, 0.6–0.7 mm wide. (Figure 6B)

Selected specimens. WESTERN AUSTRALIA: Between 35–36 miles E of Geraldton, 27 Aug. 1974, *S. Carlquist* 5447 (PERTH, RSA); 38 km S of the Geraldton Hwy turnoff on the Eneabba Rd, 28 Sept. 1976, *R.J. Chinnock* 3196 (AD, PERTH); Near Eneabba, c. 35 miles SW of Three Springs, 28 Aug. 1970, *R. Coveny* 3083 (NSW, PERTH); Intersection of Tomkins and Natta Rds, 39 km due NNE of Eneabba, 10 Sept. 1985, *J. D'alonzo* 197 (CANB, PERTH); Victoria District, Greenough River, Sept. 1901, *Diels & Pritzel* 520 (PERTH); Yanchep National Park, Yeal Swamp Rd, 4.5 km ENE from junction with Wanneroo Rd, 1 Oct. 1988, *J.M. Fox* 88/053 (CANB, PERTH); Salt Lake Rd, Shire of Dandaragan, 10 Oct. 2001, *F. & J. Hort* 1477 (PERTH); 11.5 km E of Jurien, 26 Sept. 1976, *R.W. Johnson* 3245 (BRI, PERTH); W boundary

of Watheroo National Park, 6 Oct. 1971, *R.D. Royce* 9639 (PERTH); 2.5 km along Mogumber West Rd from Brand Hwy, 9 Oct. 1995, *J.A. Wege & K.A. Shepherd* JAW 22 (MEL, PERTH); Sandtrack E of Brand Hwy at 3.1 km N of Rocky Springs Rd, South Eneabba Nature Reserve, 14 Sept. 1996, *J.A. Wege & K.A. Shepherd* JAW 207 (PERTH); 6.75 km W along Wongonderrah Rd from Brand Hwy, SSE of Cervantes, 21 Oct. 1997, *J.A. Wege* 398 (PERTH); 6.6 km E on Mount Adams Rd from Brand Hwy, 29 Sept. 2002, *J.A. Wege & C. Wilkins* JAW 615 (PERTH); c. 9 km S of Eneabba on Brand Hwy, 27 Sept. 2002, *J.A. Wege & C. Wilkins* JAW 634 (PERTH).

Distribution. A widespread species of the northern sandplains, occurring from the Geraldton area to just north of Perth. (Figure 6A)

Habitat. Grows on sandy soils over laterite or limestone, in heathland, *Banksia* low woodland and *Eucalyptus* shrubland.

Phenology. Flowers have been recorded from August to early November.

Conservation status. This species is common throughout the northern sandplain region; no conservation code applies.

Chromosome number. James (1979) recorded a count of $n = 7$ from populations 43 miles north of Perth (PERTH02943441; PERTH02943433) and 15 miles south of Lancelin (PERTH02943425). Coates & James (1979) reported the same count from 69 collection sites between Yanchep and Geraldton, although no voucher specimens from this study have been located at PERTH or UWA. The same study also documented extensive karyotype variation within and between populations of *S. crosssocephalum*.

Notes. *Stylidium crosssocephalum* can be distinguished from all other scale-leaved trigger plants by its glabrous scapes, scarious floral bract margins, and striking throat markings. (Figure 6B)

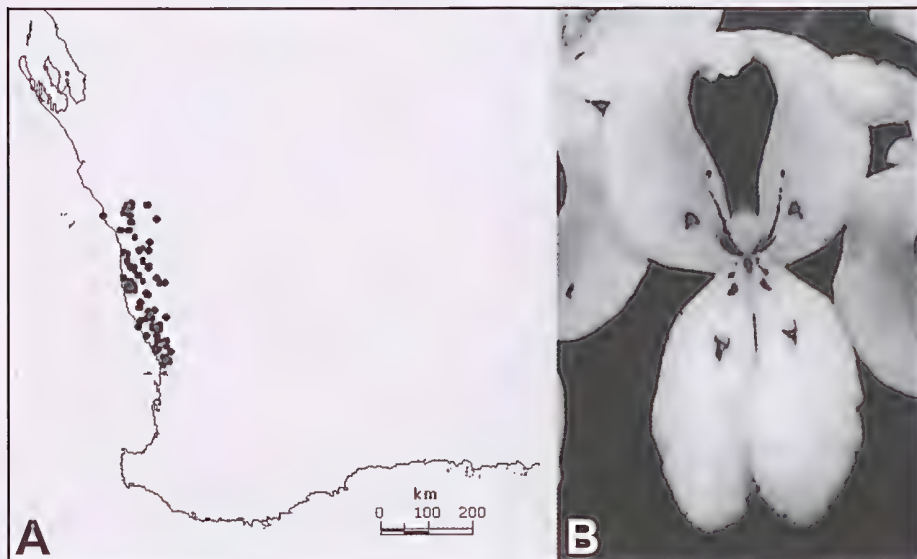


Figure 6. *S. crosssocephalum*. A – distribution map; B – flower (*Wege* JAW 596).

Stylidium crosssocephalum exhibits considerable variation in flower size both within and between populations. Subtle differences in the shape of the corolla and throat appendages, and the throat marking pattern also occur. This variation is in accordance with that often shown in species of *Stylidium* both within and between populations and is not considered here to be taxonomically significant.

Stylidium hirsutum R.Br., Prodr. 568 (1810). Base name for *Candollea hirsuta* (R.Br.) F. Muell., Syst. Census Austral. Pl. 85 (1882). Type: King George Sound, 9 Dec. 1801, R. Brown Bennett No. 2676 (*lecto*), here designated: BM!; *isolecto*: BM!, CANB!, K!, K 000060258!, MEL 2156094!, P!).

Illustrations. Graham (1832) Tab. 3194; Mildbraed (1908) Figure 21G-J, p. 75; Erickson (1958) Plate 46, No. 1 and Plate 47, Nos. 1-10, p. 156; Grieve & Blackall (1982) No. 26, p. 738 and Plate IX, photograph; Wheeler *et al.* (2002) p. 915.

Perennial herb 12–57 cm high. *Glandular trichomes* 0.2–1.6 mm long; heads red-black to black, ellipsoid; stalks translucent. *Eglandular (pilose) trichomes* 0.7–6 mm long. *Stems* somewhat condensed. *Stilt roots* glabrous. *Leaves* arranged in a rosette at the stem apex, linear, 2.5–50 cm long, 0.5–3 mm wide, apex mucronate, margin involute; surface glabrous to scabrous, papillae 0.1 mm long; stomata confined to 2 longitudinal bands on the adaxial surface. *Scale-leaves* 0.5–1.1 cm long. *Scapes* 11–54 cm high, 0.5–3 mm wide, pilose (dense at base, sparser towards apex), glandular trichomes absent or present on upper inflorescence axis only (rarely just below start of inflorescence). *Inflorescence* unbranched, head-like, 3–c.26-flowered, flowers opening from apex to base. *Bracts* 3–8 mm long, 0.3–1.6 mm wide; external surface pilose, glandular trichomes absent or present at base; inner surface glabrous. *Bracteoles* 1–3.2 mm long. *Pedicels* 1–6 mm long, pilose. *Hypanthium* ellipsoid, 2–5.2 mm long, 1.1–2.8 mm wide, glandular, pilose hairs present or absent. *Calyx lobes* free or partly fused (2 fused and 3 free), 2.4–4.3 mm long, 0.5–1.3 mm wide, glandular, pilose hairs present or absent, inner apex glabrous, margin entire; apex subacute. *Corolla* bright pink (rarely pale pink), throat white or yellow; abaxial surface glandular; tube 2–3.9 mm long; lobes vertically-paired, elliptic to obovate, apex obtuse; anterior lobes 3.5–8 mm long, 1.5–4 mm wide, margin glandular on sinus-side; posterior lobes 4.2–9 mm long, 2.5–5.1 mm wide, fused at base. *Labellum* boss white to yellowish, ovate to elliptic, 0.6–1.3 mm long, 0.4–0.8 mm wide; margin papillose, bright pink, apex 0.3–0.7 mm long; lateral appendages 0.5–1.3 mm long, bright pink, or pale pink with bright pink tips. *Throat appendages* 6; anterior appendage wing-like, white at base, pink above, 1.4–3.7 mm long, 0.8–1.5 mm wide; posterior appendages mound-like or tooth-like (bilobed, rarely trilobed), white to yellow or pale pink with bright pink tips, 0.1–2 mm long. *Column* 9–12.5 mm long; anthers greenish, subtending hairs translucent or red; pollen white to greenish yellow; stigma sessile, entire, ovate to elliptic. *Capsule* 3.5–7.5 mm long. *Seeds* yellow to pale orange-brown, ellipsoid, 0.65–0.9 mm long, 0.3–0.5 mm wide. (Figure 7B)

Selected specimens. WESTERN AUSTRALIA: Near Yorn Creek, on Yellanup Rd at Narrikup, 24 Oct. 1973, A.M. Ashby 4358B (AD, PERTH, RSA); Birdwhistle Nature Reserve, 9 July 1998, E. Bennett & A. Paton BS 9.23 (PERTH); Mount Barker-Porongurup Rd, at a point roughly N of the E end of the Porongurups, 1 Nov. 1967, S. Carlquist 3969 (AD, CANB, MEL, NSW, PERTH, RSA); Private property S of Coalfields Rd, W of Clarke Rd, 10 km WSW of Arthur River, 7 Nov. 1999, V. Crowley DKN 992 (PERTH); Kendenup, N of Mount Barker River, 17 Oct. 1951, R. Erickson s.n. (PERTH); West Mount Barren, 29 Nov. 1960, A.S. George 1825 (PERTH); W from Border Rd towards Cranbrook on N side of Stirlings, Oct. 1971, S. James 71.10/92 (PERTH); Near turnoff to Natural Bridge, Torndirrup National Park, 20 km S Albany, 4 Dec. 1986, G.J. Keighery 8572 (CANB, PERTH); 6.8 km E of Basil Rd turnoff on Cape Riche Rd, 15 Nov. 1995, T.R. Lally & B.J. Lepschi 896 (PERTH); Benn Reserve, 1 km NW of Kojonup, 14 Nov. 1999, C.M. Lewis 462 (PERTH); Ridge between Mount Gardner and False Island, Two Peoples Bay Nature Reserve, 12 Nov. 1992, C.J. Robinson 1005 (PERTH); Dryandra State Forest, 13 Nov. 1987,

D.M. Rose 493 (CANB, PERTH); SE corner of Camel Lake Nature Reserve, 4.4 km W of Formby South Rd on Salt River Rd, 27 Oct. 1998, *L.W. Sage & F. Obbens* LWS 1047 (PERTH); Reserve A21064, c. 15 km directly NE of Arthur River townsite, 28 Oct. 1998, *L.W. Sage & F. Obbens* LWS 1082 (PERTH); 2.2 km along Bluff Knoll Rd from Chester Pass Rd, Stirling Range National Park, 16 Nov. 1996, *J.A. Wege, R. Butcher & F. Valton* JAW 295 (PERTH); 400 m along Ranger's Dam track, corner Chester Pass Rd and Knoll Rd, Stirling Range National Park, 17 Nov. 1996, *J.A. Wege, R. Butcher & F. Valton* JAW 298 (PERTH); Mount Lindesay walk trail, 12 Nov. 2002, *J.A. Wege* JAW 819 (PERTH); 400 m SE on Yeriminup Rd from Frankland–Cranbrook Rd, 13 Nov. 2002, *J.A. Wege* JAW 828 (PERTH); Wandering Timber Reserve, Wandering, 13 Nov. 2002, *J.A. Wege* JAW 832 (PERTH); Albany windfarm, off Sandpatch Rd, 8 Dec. 2002, *J.A. Wege* JAW 840 (PERTH); Just E of Mount Many peaks, 9 Nov. 1974, *D.J.E. Whibley* 5202 (AD, PERTH).

Distribution. Known from the western end of Fitzgerald River National Park west to the Denmark region, and north to Wandering. (Figure 7A)

Habitat. Grows on limestone or granite-derived soils in heathland, *Agonis* or mallee shrubland, or open woodland.

Phenology. Flowers have been collected from mid-October to mid-December, with an isolated record from July.

Conservation status. This species is widespread and not threatened; no conservation code applies.

Chromosome number. James (1979) recorded a count of $n = 8$ from a population on the north side of the Stirling Range (PERTH 02947293). Coates (1982) obtained the same count from populations in the same vicinity; however, no voucher specimens have been located at either PERTH or UWA. He found these populations to be karyotypically similar. It would be of interest to obtain karyotypes for the southernmost and northernmost populations to ascertain whether there are any differences over the current known geographic range of this species.

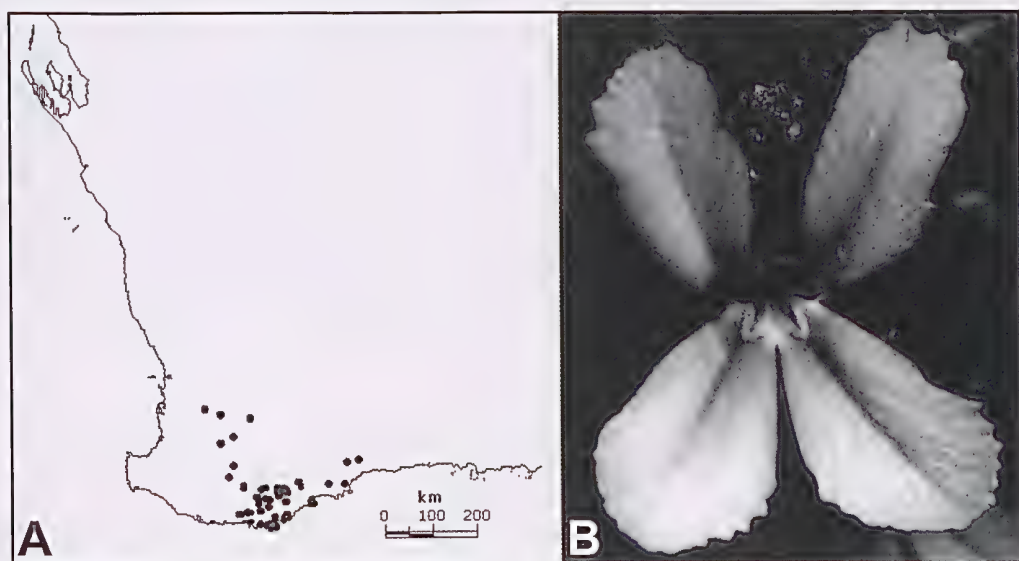


Figure 7. *S. hirsutum*. A – distribution map; B – flower (*Wege* JAW 840).

Notes. The dense, head-like and hirsute inflorescence of pink, vertically-paired flowers makes *Stylidium hirsutum* a readily identifiable scale-leaved trigger plant.

Whilst the leaves in *S. hirsutum* are typically glabrous, there are a number of populations in which they are somewhat scabrid. This character is not considered to be taxonomically significant here since these scabrid-leaved populations occur throughout the geographic range of this species. Further, there appears to be intraspecific variation in this character; in some cases this includes variation on the same individual (with older leaves appearing glabrous, and younger leaves scabrid).

A considerable amount of variation in overall plant size and flower size was also found both within and between populations of *S. hirsutum*. Differences in the size and shape of the throat appendages were also observed during examination of wet collections. The appendages on each posterior corolla lobe are usually reduced to a pair of small (0.1–0.2 mm high) mounds that may appear fused at one end. This appendage form was found consistently in JAW 840 (Albany; Figure 7B) and was observed in some plants from the following variable populations: JAW 295 and JAW 298 (Stirling Ranges), JAW 819 (Mount Lindesay), JAW 828 (Yeriminup) and JAW 832 (Wandering). The posterior appendages in the variable populations sometimes possess small (0.3–1.3 mm high) entire or bilobed (rarely trilobed) tooth-like projections. These projections are quite prominent (to 2 mm high) in some individuals from the Wandering population. This throat appendage variation is not considered taxonomically significant since species of *Stylidium* often display subtle morphological variation in their floral features within and between populations. Raulings & Ladiges (2001) observed this in their research on the eastern Australian *S. graminifolium* complex and the present author has noted it in a broad spectrum of species from the south-west of Western Australia.

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